A Bang-Up Job

Keeping Things Clean at the Contained Firing Facility

AMID rolling pastures 24 kilometers southeast of Lawrence Livermore's main site, the buildings and bunkers of the Laboratory's Experimental Test Site tuck neatly into fingers of canyons punctuated with coastal sage and blue oak. One's eye catches, perhaps, a jackrabbit, and the quiet of the landscape interweaves the tinkling song of a horned lark.

Three years ago, the site's new Contained Firing Facility (CFF) brought explosives tests indoors and minimized the dispersion of waste, providing more environmental protection than was previously possible in controlled open-air firing areas. Today, a new cleanup program developed for the CFF keeps the indoor firing chamber environment clean and maintains beryllium exposure well below established limits.

New Standard, New Challenges

The CFF was designed to conduct nonnuclear high-explosive experiments in support of the nation's Stockpile Stewardship Program. When the CFF first fired up operations, a great challenge was born. In the shift from performing outdoor detonations, a firing environment was created that would contain hazardous materials in one confined spot, which, in turn, created the need for a novel cleanup effort never before undertaken.

Central to the cleanup effort is the mitigation of harmful effects from beryllium exposure. About every third shot fired at the CFF contains beryllium, a naturally occurring metal that is used in nuclear weapons because of its capacity as a highly effective moderator and reflector for neutrons. But, as good as beryllium is for nuclear reactions, in certain forms—namely, as an airborne particulate—it can be harmful to the health and safety of workers who come into regular contact with it.

Although Occupational Safety and Health Administration standards allow for a permissible exposure limit of 2 micrograms of beryllium per cubic meter per 8-hour period, the Department of Energy (DOE) has raised the bar an order of magnitude for its facilities. DOE mandates that a working environment remain below an "action level" of 0.2 microgram of beryllium per cubic meter per 8-hour period, regardless of respiratory protection used. At this level or above, worker protection provisions must be implemented. In addition, the goal of Livermore's Chronic Beryllium Disease Prevention Program is to keep exposure levels as far below the mandated action level as is practical.

The Contained Firing Facility at Site 300 is situated in a remote area 24 kilometers southeast of Lawrence Livermore's main site.

Starting from Scratch

B Program's Site 300 facility manager Gordon Krauter and facility supervisor Jack Lowry worked with Livermore Hazards Control personnel to develop a protocol that would allow members of the CFF team to safely reenter the concrete firing chamber within a day of a detonation to retrieve experimental data and begin the cleanup procedure. The CFF team also needed access to the chamber between shots with minimal personal protective gear.

Working directly with the CFF team, Dave Zalk, an industrial hygienist, became convinced that to perform the tasks routinely done in the CFF, workers must be free to hear, speak, and move about in as unfettered a manner as possible. So the team was not content to establish a protocol that still required facility workers to don cumbersome self-contained breathing apparatus (SCBA) gear (gear that's similar to SCUBA equipment but is not for use underwater) or respirators when working in the chamber *after* cleanup. It was a tall order to fill.

To some, the prospect of reaching decontamination levels that allowed workers back into the chamber without a SCBA suit after a shot was unthinkable.

Water, Water Everywhere

In developing an optimal beryllium cleanup program, the Hazards Control team realized that water would be a major factor in the effort. Upon entering the chamber after a test shot, workers were surprised to find scattered puddles of water. They found that, by accident, the drainage conduit running the length of one of the chamber walls was not completely emptied of water before detonating the test shot. Also, the postshot levels of metals were a fraction of what they expected. This finding led to the development of the low-tech but highly effective technique to help mitigate the beryllium contamination of a blast.

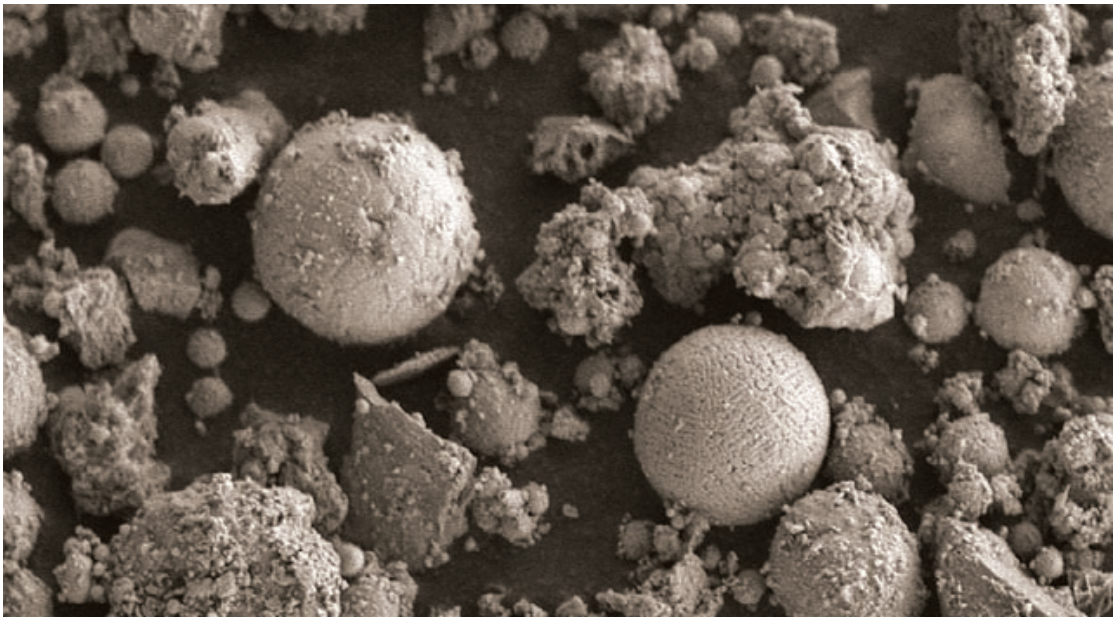
The team placed large cardboard barrels in the chamber, filled them with water, and left them in the chamber to explode during the next shot. The resulting action was not entirely unlike an indoor rainstorm: The water in the barrels aerosolized, filled the volume of the chamber, and fell in droplets to the floor, capturing much of the particulate matter produced during the shot and depositing it in a thick layer of sludge on the chamber floor. Previously, the postshot environment consisted of fine dust clouds and particulate matter easily stirred up by workers entering the chamber. But the aftermath of this water explosion was an environment in which the fine particles of beryllium and other wastes were trapped in a layer of mud, which could be scooped up with snow shovels and then transferred to the appropriate containers for disposal at a federal hazardous waste facility.

Water, Air, and . . . Hair Spray?

The three-pronged cleanup procedure that emerged as the preferred and most effective approach combines a purging of contaminated air, subsequent water washes in addition to the test shot's water blast, and a final finishing touch of hair spray. Yes—hair spray.

The first of the three steps involves a complete purging and filtering of the chamber air. The ventilation system, which is capable of 10 complete air changes per half hour, is run for 45 minutes before the 25-ton door to the firing chamber is opened. The exhaust gases from the purge are processed through a series of filters before being released to the atmosphere.

After the chamber is purged and observed for any live explosives, a CFF team wearing SCBA enters to collect the test data—a large cassette containing radiographic film that captures an image of the test material at the moment of implosion. Then the cleanup procedure, which can take up to several weeks, begins. A remotely operated oscillating washing apparatus is set up in the



A scanning electron microscope captures an image of mixed debris collected from the Contained Firing Facility's firing chamber after an experiment.

chamber, which is again sealed for the 15-minute water wash and scrub down. About 38,000 liters of recycled water later, the chamber is opened, and the team reenters to mop up. Water brooms, garden hoses, giant squeegees, and a large-capacity vacuum cleaner round out the technologies used in the procedure. "It's amazing how low-tech a solution this is to such a high-tech problem," observes hydrodiagnostic technician Keith Toon.

Because of the nature of beryllium, and the manner in which it is embedded in the nooks and crannies of the chamber walls from the force of the explosion, it is nearly impossible to remove all traces from the chamber. However, the CFF team found that the beryllium does not have to be removed from the walls to be rendered benign; it just has to be rendered immobile. As a result, the final cleanup step involves a spray application of an encapsulating solution that is similar in formula to hair spray. The solution coats and adheres to the chamber surfaces and keeps any errant beryllium particles stuck in place—until the next shot, anyway, at which time the encapsulant is knocked loose by the blast and the entire cleanup process begins again. Adding this final step shaves two weeks off the cleanup time and allows for more shots to be scheduled than was previously possible.

A Clean Sweep

Constant air monitoring at the CFF shows the results of the cleanup protocol are impressive. Concentration levels of beryllium are consistently below the mandated action level. "The success that we have achieved is a testament to the excellent teamwork between B Division and Hazards Control personnel," says Zalk.

While this massive effort may seem tedious at times, what it has offered—in addition to surpassing health guidelines—is peace of mind and a better working environment. Toon agrees. "Not having to always wear the SCBA suit has made working in this environment easier. We've got enough data now to better handle and control the beryllium. We take extra steps to make sure everything is safe. I definitely worry less."

Less worry for facility workers. Less hazardous waste for the songbirds and jackrabbits. That's something to sing about.

—Maurina S. Sherman

Two types of personal protective equipment are used at the Contained Firing Facility. The white suits shown above are worn for working outside the firing chamber and for performing dry operations in the chamber after cleanup. The brown suits are worn for wet operations (that is, cleaning and decontamination) inside the chamber.

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